

## DOCUMENT RESUME

ED 245 939

SE 044 673

AUTHOR Smith, Stuart E.; Walker, William J.  
TITLE Within-School Differences in Mathematics Achievement  
Using a Curriculum-Specific Statewide Examination.  
PUB DATE Apr 84  
NOTE 18p.; Paper presented at the Annual Meeting of the  
American Educational Research Association (68th, New  
Orleans, LA, April, 1984).  
PUB TYPE Speeches/Conference Papers (150) -- Reports -  
Research/Technical (143)  
EDRS PRICE MF01/PC01 Plus Postage.  
DESCRIPTORS Comparative Testing; \*Educational Trends; Grade 11;  
High Schools; \*Mathematics Achievement; Mathematics  
Education; \*Performance Factors; \*Secondary School  
Mathematics; \*Test Results  
IDENTIFIERS \*Mathematics Education Research; \*New York

## ABSTRACT

This study was designed to examine student achievement in mathematics by means of curriculum-based tests. The results of the 1979 New York State Regents examination in Eleventh Grade Mathematics were obtained from a representative sample of schools throughout the state. The expectations were that there would be substantial differences in achievement within schools and that between-school differences would be similar to those found in previous studies. The data from 64 schools were analyzed in a number of ways. Results for 127 teachers with more than 10 students were summarized. Mean scores, by teacher, were presented for 13 schools which had four or more teachers. In addition, achievement in different school districts was compared. The results showed surprising ranges of differences within schools. A structural model of variables influencing student learning was presented to suggest explanations for these differences. Follow-up research might focus upon specific within-school characteristics hypothesized to be related to learning outcomes. (Author)

\*\*\*\*\*  
\* Reproductions supplied by EDRS are the best that can be made \*  
\* from the original document. \*  
\*\*\*\*\*

ED245939

U.S. DEPARTMENT OF EDUCATION  
NATIONAL INSTITUTE OF EDUCATION  
EDUCATIONAL RESOURCES INFORMATION  
CENTER (ERIC)

✓ This document has been reproduced as  
received from the person or organization  
originating it.

☐ Minor changes have been made to improve  
reproduction quality.

• Points of view or opinions stated in this docu-  
ment do not necessarily represent official NIE  
position or policy.

Within-School Differences in Mathematics Achievement  
Using a Curriculum-Specific Statewide Examination

Stuart E. Smith

Alfred University

William J. Walker

Alfred University

Running head: Within-School Differences

"PERMISSION TO REPRODUCE THIS  
MATERIAL HAS BEEN GRANTED BY

*William J. Walker*  
*Stuart E. Smith*

TO THE EDUCATIONAL RESOURCES  
INFORMATION CENTER (ERIC)."

SE044673

Abstract

This study was designed to examine student achievement in mathematics by means of curriculum-based tests. The results of the 1979 New York State Regents examination in Eleventh Grade Mathematics were obtained from a representative sample of schools throughout the state. The expectations were that there would be substantial differences in achievement within schools and that between-school differences would be similar to those found in previous studies. The data from 64 schools were analyzed in a number of ways. Results for 127 teachers with more than 10 students were summarized. Mean scores, by teacher, were presented for 13 schools which had four or more teachers. In addition, achievement in different school districts was compared. The results showed surprising ranges of differences within schools. A structural model of variables influencing student learning was presented to suggest explanations for these differences. Follow-up research might focus upon specific within-school characteristics hypothesized to be related to learning outcomes.

This study was designed to examine differences in mathematics achievement in a representative sample of New York State high schools. The measure of achievement was a statewide test designed specifically for a particular mathematics course. The expectations of the research were that there would be marked differences in achievement by classrooms within schools and that differences between schools would also exist in predictable directions.

Centra and Potter (1980) have stated that many factors affect student achievement: parents, teachers, peers, schools, and students themselves. There probably never will be a single study that will adequately examine the interrelationships and effects of each of these influences. Several researchers "have advocated moving away from between-school research, in which mean student achievement and aggregate school or teacher characteristics are related, toward research on within-school and within-classroom variables. The evidence clearly points to more variability in student learning outcomes within schools than between schools" (p. 278). Within-school variables have a greater impact on both teacher and student behavior, and ultimately on student achievement.

Although teachers have been studied as to who they are and what they do, not much attention has been focused upon what they produce (Schofield & Start, 1979-80). The three major categories found in the literature include definitions of teacher effectiveness based on teacher traits or characteristics (called presage studies), definitions based on evaluation of teacher behaviors during teaching (process studies), and definitions based on the measurement of pupil achievement (product studies). Research on teacher effectiveness has been criticized because of the tradition of using presage and process variables, instead of product variables, as criteria of teacher

effectiveness. To avoid a circular argument, presage and process variables should be viewed as potential predictors of teacher effectiveness which will ultimately be based on product criteria (changes in pupil achievement).

Some researchers believe that school effectiveness should be evaluated by assessing pupil performance on tests that are related to the content of specific courses. In a study conducted in secondary schools in the Republic of Ireland, Madaus, Kellaghan, Rakow, and King (1979) compared student performance on standardized tests with performance on examinations designed for specific curricula. They found that curriculum-based instruments were more sensitive to differences in school characteristics than were standardized tests.

Research has suggested that achievement in mathematics, or in any subject that is likely to be learned primarily in school, will demonstrate stronger school effects than will subjects where knowledge is accumulated both in school and outside of school--English and social studies, for example. Welch, Anderson, and Harris (1982) discovered that the variation in the amount of mathematics studied accounted for 34% of the total variation in achievement scores. Background variables accounted for 25% of the variance. The correlation between quantity of mathematics and mathematics achievement was .73. Stigler, Lee, Luckier, and Stevenson (1982) also suggest that the amount of time devoted to mathematics is related to mathematics achievement. They believe that the poor performance of American children when compared with children from Japan and Taiwan results from the fact that Americans receive much less instruction in mathematics and spend much less time doing homework.

#### Methods

##### Subjects

The sample consisted of 4,873 pupils of 127 teachers in 64 New York

State public and private secondary schools. This was actually a sub-sample of the 5 to 8% representative sample that the State Education Department Division of Educational Testing obtains from all the schools administering the examination throughout the state. The state sample consisted of 6,819 pupils from a population of 77,897 taking the examination in June 1979.

#### Instrument

The New York State Education Department provides a standardized curriculum-based test for 22 of its secondary school subjects. Called Regents examinations, these tests serve a number of purposes, such as setting and maintaining standards in the most frequently studied subjects, and furnishing valid and reliable pretested examinations for teachers of the state. They also help define important instructional objectives and serve to motivate pupils (Division of Educational Testing, 1981).

More than a million Regents examination papers are written each year involving approximately half of the pupils in grades 9 through 12. Examinations are cooperatively developed by practicing teachers and State Education Department specialists. Each examination is based on a state syllabus.

Each year, summary data are reported so that individual schools can compare the performance of their pupils with the rest of the state. On the June 1979 Regents examination in Eleventh Year Mathematics, the percent passing in the sample of 6,819 was 74.7%; the percent passing in the population of 77,897 was 75.5%. The mean of the sample was 73.0 with a standard deviation of 18.4. The Kuder-Richardson Formula 21 reliability coefficient was .95 (Division of Educational Testing, 1979).

Procedures

For this research, the New York State Education Department made available the examination papers of the review sample of pupils participating in the June 1979 Regents examinations in Eleventh Year Mathematics. The data were summarized primarily to illustrate the differences within schools, although between-school differences were also examined. The results were then related to previous State Education Department studies and used as a basis for suggesting factors related to differences in achievement.

Results

Summary information was tabulated for 127 teachers, each of whom had at least 10 pupils per class (Table 1). The typical passing grade for the Regents examination is 65%. Table 1 shows the number of teachers whose mean pupil score was above and below passing. The mean scores for 17% of the 127 teachers were below passing. The mean passing rate for 6% of the teachers was above 90%, and the mean scores for 2% of the teachers were below 50%.

---

Insert Table 1 about here

---

There were 13 schools having four or more teachers of Eleventh Year Mathematics. Table 2 presents mean scores for each teacher, the numbers of pupils contributing to the mean, and the range of mean scores per school. School A, for example, has a fairly narrow range of means among the four teachers involved. The pupils of teacher no. 1 averaged 93, whereas those of teacher no. 4 averaged 83, a range of 10. Since the statewide achievement mean was approximately 73%, it can be seen that the mean achievement

in school A was well above that of the state.

---

Insert Table 2 about here

---

In school M, on the other hand, there is a much wider range of mean scores among the six teachers. The pupils of teacher no. 1 of school M achieved a mean of 91% while those of teacher no. 6 obtained 55. The 36-point range in mean scores in school M is the largest of the 13 schools.

To provide a rough estimate of statistical significance of differences, it was calculated that for approximately 25 subjects, a mean of nine points is statistically significant at the .05 level (two-tailed test). Obviously, for larger samples, smaller differences would result in statistical significances.

Although the thrust of the present study was upon within-school differences, a secondary objective was to determine if between-school differences parallel findings from previous studies. Positive findings would suggest that the data were reasonably representative of typical studies of between-school differences.

An earlier Regents study (Bureau of School Programs Evaluation, 1969) found that several community characteristics appeared to be related to average achievement of school systems. The Iowa Tests of Basic Skills was administered to more than 45,000 students. This 1969 study categorized systems according to the legal definition of each district, which was mainly related to school size. Large and medium school systems ranked lowest, with small rural systems ranking almost as low. Village systems, many of which are suburban schools,

scored highest. The study noted that size alone was not the determining factor in achievement since large city systems and small rural systems both scored lowest of the five categories.

The findings presented in Table 3 are similar to those of the 1969 study, with the exception that small cities rather than village schools achieve at the highest level. It should be noted, however, that there was one very low scoring village school in the present study which depressed the mean for villages. Small rural schools exhibited the lowest achievement with regard to averages of mean scores followed by medium rural, and large and medium city schools. Achievement in small cities was highest, followed closely by large rural school districts.

---

Insert Table 3 about here

---

The trends of the present study seem to be similar enough to the earlier study to indicate that performance in mathematics was similar, although not identical, to that on standardized achievement tests. This would suggest that achievement trends by size of district found in the 1960's prevailed a decade later when curriculum-based tests were employed.

#### Discussion

The surprising finding was the large difference in mathematics achievement within schools. At this point we can only speculate with regard to explanations for the findings. The first impression might be that teacher behavior might account for the major portion of these differences. It would seem reasonable to assume that superior teachers produce superior results and that these differences can be readily assessed. Although teacher performance is

undoubtedly a factor to be considered, a number of other variables must be taken into account.

The New York State Division of Educational Testing (1979) states that there are a number of factors that may influence results on Regents examinations, such as the ability of pupils who elect to study the subject, local school policies concerning who is admitted to the examinations, and pupil motivation as influenced by environmental conditions. Higher achievement in a particular subject does not necessarily indicate superior teaching of that subject.

Centra & Potter (1980) have described a structural model that helps clarify the complex interaction of variables affecting achievement. Seven groups of variables are described: (a) school characteristics, (b) within-school conditions, (c) teacher characteristics, (d) teacher behavior, (e) student characteristics, (f) student behavior, and (g) student learning outcomes.

It is assumed that there was a considerable amount of variability on each of these characteristics in the sample employed. It seems reasonable to further assume that there would be less variation on each variable within a single state than if a national sample were being examined. Future research might minimize the effects of these variables by attempting to hold more or less constant variables such as social class, grouping practices, teacher characteristics, etc.

The present study included a variety of school districts which differed with regard to such factors as size, taxable wealth, social class, and urbanization. It seems reasonable to assume that there were variations with regard to administrative control, tracking, and school environment. The

quantity of schooling is less varied, since the state mandates minimum numbers of contact hours and school days.

New York State has fairly specific degree and certification requirements for teachers. However, one would expect that differences exist with regard to knowledge of subject, social class, values, and expectations. One could further speculate that teacher behavior, student characteristics, and student behavior would vary widely. Student learning outcomes would be the result of the total interaction of all of the variables described in the model and would be expected to result in wide differences in achievement both in cognitive and non-cognitive areas.

Centra and Potter (1980) state that student behavior and student learning outcomes are most directly influenced by student characteristics, teaching performance, and within-school conditions. There is more variability in student outcomes within schools than between schools. Research efforts would be more fruitful if the focus were upon within-school differences.

There is a growing trend for studies to focus upon student achievement (product) rather than upon teacher traits and teacher behavior. Madaus et al. (1979) stated that the important factors influencing achievement are academic demands of courses, the commitment to academic values, the investment of time on study and homework, and a general environment of high expectations by both pupils and teachers. Their research suggested that school resources clearly contribute to student achievement, a finding that runs counter to studies suggesting that social background is more influential than the school (Coleman et al., 1966).

McDonald (1976) demonstrated that certain teaching behaviors accounted almost entirely for pupil achievement over the course of a year. He believes

he has isolated true teacher effects. A related finding was that there seemed to be no common pattern of effective performance, a result that suggests that the concept of generic teaching skills needs to be revised.

Brophy (1979) believes that teachers make a difference. He stated that effective teachers know how to establish a classroom learning climate that enhances the time spent on fruitful learning activities. Research indicates considerable support for direct instruction in which pacing is rapid in the sense that the objectives of the curriculum are achieved. Research that focuses upon the teacher rather than the school shows that some teachers achieve more effective student learning than others and that this success is associated with consistent differences in teaching style.

In the present study, surprising differences in the mean scores of teachers within the same school were found. The range of mean scores was large enough to suggest that researchers should seriously entertain the proposition that teachers may differ considerably in their effectiveness. Inasmuch as teacher characteristics presumably are within the control of school policy makers, research centering on teacher effectiveness should be encouraged.

In summary, the findings of the present study indicate a wide variation of pupil achievement within schools in a course covering high-level cognitive content. In addition, the findings between schools were similar to those of previous between-school research. The focus of the study was upon student achievement rather than upon teacher characteristics or teacher behavior. Learning outcomes were measured by curriculum-based tests rather than by standardized achievement tests. The wide within-school differences in achievement suggest a number of fruitful avenues for further research. To

get a clearer picture of teacher influence, studies that focus upon cognitive achievement of the type which is more likely to occur mainly in school (mathematics or foreign languages, for example) should prove to be profitable. Where possible, achievement tests designed for specific curricula should be employed. Relating future studies to existing instructional models such as the one developed by Centra and Potter (1980) should provide a clearer theoretical base.

References

- Brophy, J. E. Advances in teacher research. Journal of Classroom Interaction, 1979, 15, 1-7.
- Bureau of School Programs Evaluation. Toward an evaluation of education. Albany, New York: State Education Department, 1969.
- Centra, J. A., & Potter, D. A. School and teacher effects: an interrelational model. Review of Educational Research, 1980, 50, 273-291.
- Coleman, J. S., Campbell, E. Q., Hobson, C. J., McPartland, J., Mood, S. M., Weinfeld, F. D., & York, R. L. Equality of Educational Opportunity. Washington, D. C.: U. S. Government Printing Office, 1966.
- Division of Educational Testing. Percentile equivalents and reliability data for the June, 1979 Regents examination. Albany, New York: The State Education Department, 1979.
- Division of Educational Testing. Evaluating the effectiveness of education in New York State. Albany, New York: The State Education Department, 1981.
- Madaus, G. F., Kellaghan, T., Rakow, E. A., & King, D. J. The sensitivity of measures of school effectiveness. Harvard Educational Review, 1979, 49, 207-230.
- McDonald, F. J. The effect of teaching performance on pupil learning. Journal of Teacher Education, 1976, 27, 317-319.
- Schofield, H. L., & Start, K. B. Product variables as criteria of teacher effectiveness. Journal of Experimental Education, 1979-80, 48, 130-136.

Stigler, J. W., Lee, S., Lucker, W., & Stevenson, H. W. Curriculum and achievement in mathematics: a study of elementary school children in Japan, Taiwan, and the United States. Journal of Educational Psychology, 1982, 74, 315-322.

Welch, W. W., Anderson, R. E., & Harris, L. J. The effects of schooling on mathematics achievement. American Educational Research Journal, 1982, 19, 145-153.

Table 1

Distribution of Mean Scores on Eleventh Year Mathematics  
Examinations of Pupils of 127 Teachers<sup>a</sup>

| Mean Score | Number of<br>Teachers | Percent of<br>Teachers |
|------------|-----------------------|------------------------|
| Passing    |                       |                        |
| 90-99.9    | 8                     | 6                      |
| 80-89.9    | 23                    | 18                     |
| 70-79.9    | 61                    | 48                     |
| 65-69.9    | 9                     | 10                     |
| Failing    |                       |                        |
| 60-64.9    | 13                    | 7                      |
| 50-59.9    | 10                    | 8                      |
| 0-49.9     | 3                     | 2                      |
| Total      | 127                   | 99                     |

<sup>a</sup>There were at least 11 pupils per teacher.

Table 2

Distribution of Mean Scores, by Teacher, on the Eleventh Year Regents  
Examinations for 13 Schools with Four or More Teachers

| School | Mean Score by Teacher |        |        |        |        |        | Range |
|--------|-----------------------|--------|--------|--------|--------|--------|-------|
|        | 1                     | 2      | 3      | 4      | 5      | 6      |       |
| A      | 93(55) <sup>a</sup>   | 86(62) | 84(72) | 83(69) |        |        | 10    |
| B      | 83(32)                | 78(43) | 73(33) | 66(21) |        |        | 17    |
| C      | 75(44)                | 71(35) | 63(26) | 58(41) |        |        | 17    |
| D      | 81(109)               | 74(31) | 70(47) | 61(61) |        |        | 20    |
| E      | 91(21)                | 64(67) | 64(26) | 59(21) |        |        | 32    |
| F      | 81(24)                | 78(48) | 75(26) | 72(11) | 71(17) |        | 10    |
| G      | 77(47)                | 74(28) | 74(70) | 72(19) | 67(16) |        | 10    |
| H      | 87(40)                | 85(47) | 85(22) | 75(21) | 74(17) |        | 15    |
| I      | 94(30)                | 77(82) | 76(61) | 74(22) | 72(30) |        | 22    |
| J      | 80(14)                | 75(38) | 72(59) | 71(63) | 56(12) |        | 24    |
| K      | 82(24)                | 81(29) | 79(22) | 78(21) | 77(33) | 70(81) | 12    |
| L      | 88(39)                | 86(44) | 86(38) | 73(41) | 71(41) | 68(38) | 20    |
| M      | 91(25)                | 77(70) | 65(56) | 65(25) | 58(13) | 55(25) | 36    |

<sup>a</sup>The figure in parentheses indicates the number of pupils on which the mean is based.

Table 3

Mean Scores in Eleventh Year Mathematics  
by Type of School District

| School<br>Classification | Number of<br>Schools | Mean<br>Score | Range of<br>Mean Scores |
|--------------------------|----------------------|---------------|-------------------------|
| Small City               | 8                    | 78.1          | 14.0                    |
| Large Rural              | 15                   | 75.8          | 14.3                    |
| Village                  | 6                    | 73.3          | 25.0                    |
| Large and Medium City    | 12                   | 70.2          | 19.1                    |
| Medium Rural             | 8                    | 70.2          | 34.5                    |
| Small Rural              | 4                    | 66.4          | 31.4                    |